



Fuel Systems



Fuel Systems

Sierra-CP has a complete range of measurement and conditioning solutions for fuel and other liquids and gasses associated with engine and vehicle testing. With over 40 years of experience in fluid flow measurement, Sierra-CP brings tremendous expertise and passion to this sector. Sierra-CP now offer a range of fuel temperature conditioning and settable fuel pressure delivery modules for steady state and transient testing, to compliment the range of gravimetric, transient and coriolis fuel meters available.

These are modular units and can be integrated into no Sierra-CP host systems, and introduced to the test cell as requirements dictate. As the demand for fuel systems have increased CP have developed an independent fuel controller, which will allow any CP fuel system to be used with a non CP host control system, via either an Ethernet AK protocol or analogue interface. This 4U 19" rack mountable fuel controller can be easily integrated into an existing control system cabinet, to allow control of fuel measurement, fuel temperature and pressure conditioning, and control of other CP in-cell ancillary equipment, as required.



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Fuel Measurement System

FuelTrak - 1000 - 3000

CP Engineering



Introduction

The FuelTrak-1000 and FuelTrak-3000 Gravimetric Fuel Measuring Systems are compact, high precision instruments for measuring specific fuel consumption of diesel and petrol engines developing up to 1000 kW for the FuelTrak-1000 and engines developing up to 3000kW for the FuelTrak-3000. The FuelTrak-1000's and 3000's wetted parts are all stainless steel, enabling Reference and unusual fuels to be used.



The Photo shows the main components of the FuelTrak-1000 and 3000 Systems, these include the stainless steel Fuel Weigher, the electronic Control Unit, the Fuel Fill Solenoid Valve (also available in Stainless steel), the CP128 Control and Monitoring Card (DL-FMS-03) and the Connection Loom.

Benefits and Features

- Holding tank de-gasses spill back fuel
- Self calibrating
- Run in hardware mode for a smart in-cell holding tank
- Small size, wall or post mount

Applications

- Specific Fuel Consumption Measurements
- Special Fuels Research and Development
- Fuel Additives and Resultant Effects
- Emissions Certification Work



System Description

The FuelTrak-1000 and 3000 systems are controlled and monitored by CADET V14, this records and can display the data obtained.

The fuel weighers use a 20N and 50N loadcell respectively to measure consumed fuel. They also cancel any vibration mechanically, as the construction is stiff and has no moving parts.

The benefits of this design include a high degree of linearity and a reduction of inaccuracies by not using a vibration dashpot.

The fuel cells have volumes of 1 and 3 Litres and are mounted on top of the 20N and 50N loadcells, the fuel cell has four ports all connected by lightweight bellows. These ports are for Fuel Feed, Fuel Supply, Fuel Return and Vent, as shown in the photo.

Calibration is achieved by automatic application of a 100gram calibration weight on to the fuel vessel for the a FuelTrak 1000 and a 480gram calibration weight for the FuelTrak 3000. The resulting increase in the analogue output signal is used to calibrate the system at the prevailing fuel level.

When the system is not configured for operation by CADET V14 and the DL-FMS-03 card it can run in a hardware only mode, the Control Unit will maintain the fuel at a pre-set level, by opening and closing the fuel 'FILL' solenoid valve. This enables the FuelTrak systems to run as an in-cell header tank automatically.

Steady State Fuel Measurement

CADET V14 closes the solenoid valve so that fuel is taken only from the vessel when a fuel measurement is initiated. After a short settling time, the net mass of fuel taken from the vessel (over the desired sampling time) is measured. The CP128 card samples data at 10 kHz and returns the *averaged* value back to CADETV14 at up to 10 Hz. At steady state conditions the engine power is known and CADET V14 calculates brake specific fuel consumption.

Dynamic Fuel Measurement

The FuelTrak-1000 and 3000 are capable of monitoring fuel during a period of a test stage, or cycle, for a specific time as short as 100 ms. The stage, or cycle, is then repeated and the average fuel consumption rate calculated as a true dynamic reading.

Additional Options

The FuelTrak-1000 and 3000 can be linked up to various other options offered by CP Engineering. These include a Fuel Conditioning Unit (FCU-1000), allowing the user to set the required temperature of the supply fuel to the engine.

FuelTrak-1000-3000 - 3.1



Schematic Diagram



Customer Responsibilities

The customer should make available or prepare the following services:

- Electrical Power Supply
- Fuel Supply Line/s
- Fuel Return Line
- Fuel Vent Line

These will be confirmed and discussed during the project phase.

CP Engineering



Specification and Performance Data

FuelTrak - 1000

Compatible Fuel Types	Petrol, Diesel (For Reference Fuels Contact CP)
Mass Signal Interface	0 to 5 V DC calibrated as 0 to 1,000 grams
Cal/Fill Interface Contact/Opto coupled	5 to 24 Volts DC
Designed max flow Range	300 kg/hr
Designed max engine power	1000kW
Temperature Range	0 to 65°C
Accuracy	±0.05% of reading, ±0.03 grams
Pipe Connections	3/8" BSP(P) Female.
Dimensions - Weigher	W=230mm, H=330mm, D=180mm
Dimensions – Control module	W=220mm, H=120mm, D=85mm
Control module power supply	230v <1A, and 24v < 0.5A

FuelTrak - 3000

Compatible fuel types	Petrol, Diesel (For Reference Fuels Contact CP)
Mass Signal Calibration	0 to 5 V DC calibrated as 0 to 5,000 grams
Cal / Fill interface	Opto-coupled link configurable for volt free contact, 5vTTL, 12v or 24v options.
Designed max flow range	1800 kg/hr
Designed max engine power	3000kW
Temperature range	0 to 65°C
Accuracy	±0.05% of reading, ±0.03 grams
Port connections	
Air	G1/8"
Fuel Feed, Engine Feed	JIC –16 (1.5/16 x 12 UNF)
Engine Return, Vent	JIC –12 (1.1/6 x 12 UNF)
Dimensions - Weigher	W=310mm , H=600mm, D=180
Dimensions – Control module	W=220mm, H=120mm, D=85mm
Control module power supply	230v <1A, and 24v < 0.5A
Air supply requirements	Max 5 bar, nom 2 bar, filtered and dry.







Fuel Measurement System

Transient FuelTrak



Introduction

The Transient FuelTrak fuel consumption meter is a technical development of the existing gravimetric fuel measurement system manufactured by CP Engineering enabling continuous and dynamic fuel flow as well as density measurement.



The meter utilises two measuring techniques to determine and confirm the fuel consumption of the engine. The two techniques are a gravimetric fuel measurement system and a coriolis flow meter. The two measurement systems are linked together to attain the benefits that each system can offer. They can also be used to verify each other's performance and operation for calibration purposes.

Features

- o High accuracy measurement
- o Continuous fuel measurement capability
- o Two measuring techniques allows cross referencing for calibration
- o Fuel density measurement
- o Bubble separation on return line type fuel systems
- o Stainless Steel wetted parts for reference and special fuels
- o Fuel temperature conditioning option. See Data Sheet FCU-1000
- o Compact process unit allows positioning close to engine
- o PID control

Applications

- o Specific fuel consumption measurements
- o Special fuels research and development
- o Fuel additives and resultant effects
- o Emissions certification work



System Description

The system provides all the existing features of the standard gravimetric fuel measurement system, such as bubble separation from returned fuel, together with continuous flow operation and measurement and fuel density readings.

The two measuring techniques of a standard steady state gravimetric fuel meter and a coriolis meter is utilised to determine the dynamic fuel consumption of the engine. The gravimetric fuel meter is connected to the engine's feed and spill return lines. The coriolis meter is connected to the supply port of the gravimetric fuel meter to measure the amount of 'make up' fuel required to maintain the mass of fuel in the measurement tank in the gravimetric fuel meter at a constant 500grams, this being approximately half full.

A rotary control valve positioned by a PID loop in the control system allows fuel to pass through the coriolis meter into the measurement tank at the required rate to maintain this mass at 500grams. In this way any variation of mass seen in the measurement tank above or below 500grams is corrected and measurement by the coriolis meter.



The system is protected by a solenoid valve and level switches preventing fuel flow into the unit in the event of overfill.

The heat exchangers fitted to the supply, feed and return lines can be connected to the CP Fuel Conditioning Unit (FCU-1000). When connected to a suitable chilled water supply the FCU will provide conditioning of the fuel in the system at three points, hence maintaining the correct temperatures for reproducibility of tests or to meet relevant standards.



User Responsibilities

The User should make available or prepare the following services:

- Single phase 230 / 110 volt electrical power supply (available from CADET)
- 24volt DC supply (available from CADET)
- Fuel supply line/s
- Fuel to engine line
- Fuel spill return line
- Fuel vent line

These will be confirmed and discussed during the proposal or project phase.

Specification and Performance Data

System 100 measures flow range up to	0 to 100 Kg/hr
System instantaneous accuracy	± 0.5% for flows from 3g/sec to 30g/sec
System averaging accuracy	±0.1%
Materials of Manufacture	316 304, Stainless Steel Hastelloy C-22
Density Measurement Range	0-5000 Kg/m ³
Density Measurement Accuracy	±2.0%
Compatible Fuel Types	Petrol, Diesel
	(For reference fuels contact CP)
Mass Signal Interface	0 to 5 V DC calibrated as 0 to 500 grams
Cal/Fill Interface Contact/Opto coupled	5 to 24 Volts DC
Temperature Range	0 to 65°C
Dimensions (overall)	600mmH x 600mmW x 200mmD
Weight	20 kg
Pipe Connections	3/8" BSP(P) Female.





Fuel Conditioning Unit

FCU-1000, 3000

FCU-1000, 3000 - 3.1



Introduction

The Fuel Conditioning Unit is designed to enhance the features of the FuelTrak-1000, 3000, Transient FuelTrak or other Fuel Measurement provides Systems. lt computer controlled fuel supply temperatures, to either combat extreme ambient conditions, high fuel return line temperatures or to match specific test requirements. There are two elements to the FCU these are the Control Enclosure and the Process Enclosure.



The Fuel Conditioning Unit's Process Enclosure main components are:

- Circulating Pump
- o Header Tank
- o Immersion Heater
- Flat Plate Heat Exchanger fed by Chilled Water Circuit
- Temperature and Level Sensors

Benefits and Features

- o Condition Fuel using set points from CADET test
- o Integrate into existing fuel systems
- Enclosure allows wall or post mounting

Applications

- o Emissions Certification Work
- o Simulating different environments

FCU-1000, 3000 - 3.1



System Description

The Control Enclosure marshals the mains switching and i/o associated with the control of the Process Enclosure. The Process Enclosure requires one set of Feed and Return lines for the Process Water Circuit and one for the Chilled Water Circuit, this minimises the pipe-work in the test cell. The temperature in the header tank is maintained or adjusted by directing the intake closed loop water in one of two circuits. To cool the process loop water, it is diverted through the chilled water circuit's heat exchanger before return to the header tank. To warm the process loop water circuit, the heat exchanger is by-passed and the immersion heater in the header tank is turned on. A PRT mounted in the header tank constantly monitors the temperature of the process water. There is also a water level safety switch in the header tank. This sends a digital signal to CADET V14 which prevents the Immersion Heater being operated when there is insufficient water, and provides feedback to the operator via the display.

The process water from the header tank is fed through a second Flat Plate Heat Exchanger to cool or warm the fuel from the FuelTrak unit before it is fed to the engine. This second Heat Exchanger should be mounted as close as possible to the final fuel intake of the engine to reduce the 'slug' of fuel proceeding the newly conditioned fuel.

Additional Options

An additional Flat Plate heat exchanger can be included with the system where fuel return temperatures are expected to be high. This Heat Exchanger can be fed by a branch off the chilled water supply, to reduce the temperature of the return fuel before it is returned to the FuelTrak unit, temperature control of this Heat Exchanger is manually adjusted with a bypass valve.

CP can also offer an uprated version of the FCU to combat extreme temperature requirements or very large fuel flows and spillback levels.

Customer Responsibilities

The customer should make available or prepare the following services:

- Electrical Power Supply
- Chilled Water Supply

These will be confirmed and discussed during the project phase.

FCU-1000, 3000 - 3.1





Specification and Performance Data

Header Tank Size	8 Litres
Immersion Heater Power	3kW (1000) 10kW (3000)
Maximum Standard Fuel Temperature	60°C
Minimum Standard Fuel Temperature	10°C Above Chiller Supply Temp
Pipe Fittings for Process Water	1" BSP Female & 22mm Compression
Pipe Fittings for Chilled Water	15mm Copper pipe
Outer Dimensions of Process Enclosure	500x500x250mm
Outer Dimensions of Control Enclosure	250x250x200mm
Secondary Heat Exchanger Fittings	1⁄2" BSP Female
Cadet Digital Outputs Required	2 off
Cadet Digital Inputs Required	1 off
Cadet Analogue Inputs Required	1 off
Power supply for Control Enclosure	13A mains

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Fuel Pressure Regulation

Fuel Pressure Regulation Board – 3.2



Introduction

The fuel pressure regulation board has been designed to allow a range of settable fuel delivery pressures to be achieved.

The pump supplied is a 12Volt Automotive type. The fuel flows from the pump to the manifold block which is used to mount the pressure and temperature sensors.

The constant flow rate from the pump is typically greater than the engine consumption. This over supply of fuel results in an increase in pressure seen at the regulator. When the resultant pressure is greater than the regulator setting the excess fuel is by-passed through the regulator to the fuel meter return line.

Adjustment of the fuel pressure is achieved by way of an Electro Pneumatic Air Pressure fitting. This allows an E/P device to control the air pressure acting on the regulator diaphragm.

Any spill back fuel from the engine is fed back into the pressure control unit, and is then fed to the fuel meter return line.

The pressure regulation unit is supplied with a control box which interfaces with CADET Control system to allow control of the fuel pressure. A solenoid valve is fitted on the engine feed connection to allow cutoff of the engine fuel supply for safety.

A manual fuel control board is also available, where by the delivery pressure is set by manually adjusting the pressure regulator. A delivery pressure gauge is supplied to determine fuel pressure.

Control Data

Pump Maximum Flow Rate @ 12V	50 gram / sec
Regulator Maximum Bypass Flow rate	60 gram / sec
Regulation	< 0.1Bar / gram / sec
Pressure Control Range	0.5 Bar to 5.0 Bar (Gauge)
Compatible Fuels	Gasoline and Diesel
Fuel Connections	½" Female BSP

Custom fuel pressure regulation units are available with extended delivery conditions

NOTE: The customer is responsible for meeting any installation or operating regulations or requirements with regards the fuel. The customer should also provide a 5 bar filtered air supply.

Fuel Pressure Regulation Board – 3.2



System Description









Fuel Controller